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ABSTRACT

This paper focuses on item design considerations faced by instructional designers and evaluators when using computer videodisc delivery systems as a means of assessing learner comprehension and competencies. Media characteristics of various interactive computer/videodisc training systems are briefly discussed as well as reasons for using such systems for testing. Suggestions for test item design at various skill performance levels are offered for use with a single screen interactive computer/videodisc system with a high resolution graphics monitor having overlay capabilities. Test item designs are specified and briefly discussed for the following typical skill performance objectives--to assess the learner's comprehension of a particular part removal and replacement, identify components, discriminate between components, interpret results and equipment readings, specify location or set-up, and assess problem-solving skills involved in troubleshooting. Some related test development topics are reviewed, and suggestions are made for further research. (LMM)

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LEARNER ASSESSMENT METHODS USING A COMPUTER BASED INTERACTIVE VIDEODISC SYSTEM

Paper Presented at the Annual Meeting of The Association of Educational Communication and Technology, Dallas, 1984

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Learner Assessment Methods Using A Computer Based Interactive Videodisc System

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Introduction

The hardware and software integration of microcomputer and videodisc technology affords instructional designers a unique and challenging training medium. This individualized environment offers the capabilities of computer-based instruction and audio-visual technologies within a single delivery system. Computer/videodisc training systems may also be used as assessment mediums for performance based objectives requiring visual formats. The challenges of designing for this rich training environment lies ahead for evaluators and instructional designers.

Research investigating the use of audio/visual testing began in the mid 1940's with the use of motion films and slides using synchronized recorded sound. The major thrust towards the use of media for testing purposes occurred at the time of World War II when there was a real need to train large groups of men. (Tanner and Dwyer, 1978).

Thelen (1945) used slides and sound methods, which he believed could be used as a valid prediction of behaviors, to evaluate overt learner responses.

> Fundamentally the method of evaluation is to put the students into situations likely to result in experiences engendering overt responses which can be used for valid prediction of behaviors assumed to constitute the goals of education. (Thelen, 1945, p. 33)

Gibson (1947), working for the Army Air Force Aviation Psychology program, identified the need for alternative testing methodologies to evaluate human skills and aptitudes requiring primarily pictorial rather than lingustic presentation.

> It is likely that there are types of human aptitudes and abilities which cannot be adequately measured by the relatively static problems and questions presented by ordinary test methods but which can be demanded by setting up tasks

> arising from the continuous flow of events portrayed on the motion picture screen. (Gibson, 1947, P. 98)

This paper begins with a brief discussion of the characteristics of various interactive computer/videodisc training systems. An discussion of reasons why a computer/videodisc systems may be used for testing will be presented. The primary paper focus will address item design considerations faced by instructional designers and evaluators when using these delivery systems as a means of assessing learner comprehension and competency. Some related test development topics will be investigated. Lastly, suggestions for further research investigations will be given.

This paper does not argue for or against the use of visually based test items; it will not investigate relationships which may exist between the use of visually based test items and spatial visualization abilities. While it is critical that this relationship be explored, it is beyond the scope of this paper.

Media Characateristics of Computer/Videodisc Training Systems

It is important to investigate the media attributes available with an interactive computer/videodisc system. The use of the computer as a training medium offers all the features of conventional computer-based instruction (CBI) (see Figure 1). Stand alone CBI may also use one of the audio tracks on the videodisc to enhance the primarily text and graphic presentation of the computer. The videodisc player offers all of the traditional audio/visual training media attributes in differing combinations (depending on the hardware and software capabilities of the particular delivery system).

The integration of the media capabilities of a computer/videodisc training system are determined by appropriate instructional design strategies and visual design and message design techniques. Within the limitations imposed by the hardware and software capabilities of a particular delivery system, the instructional message should be dictated by sound instructional design strategies.

Some computer/videodisc systems use a two screen presentation system with one screen for computer generated output and the other screen for the images from the videodisc player. With these systems the software controls the output from the videodisc. Other systems use one screen (usually an NTSC monitor

although high resolution graphic terminals are also used with more sophisticated systems) to display both the computer generated output and the images from the videodisc. Some of the more advanced systems allow the computer generated output to be overlayed directly on top of the visual images from the videodisc. In other words, the computer and videodisc output may appear concurrently on the screen. Other one screen systems only allow either computer generated output or visuals from the videodisc on the screen at any one time.

The particular configuration of any one system will directly influence instructional strategies and visual design and message design decisions. Hiscox (1981) summaries the success of this medium in stating,

> The success of the videodisc in instruction will depend largely on how well they maintain students motivation by providing attainable goals, frequent feedback, appropriate difficulty and minimized failure, and whether they allow for such individual differences as attributes and interests, time required for learning, students konwledge base, and generalized ability.

Why Use Computer/Videodisc Systems for Testing?

One might question the use of computer/videodisc hardware/software systems to test learner comprehension and mastery of skills. What potential benefits are gained over the use of a paper and pencil test? Are the additional costs associated with the design and production warranted?

Carpenter, et. al. (1954) identifies the following advantages or motion picture testing:

- o Action and motion - presents complex motion or actions and complex relationships.
- o Spatial time elements of performance.
  - Presents sequence of events,
  - Understanding of functions,

- Cause and effect relationships.

o Concreteness and specificity dimension.

- Film problems may be presented concretely in terms of machines, parts, tools and solutions worked out in terms of the motion-pictorial stimuli without the necessary of translation from verbal abstraction to visual forms and back again. This may allow students to have a more consistant and uniform frame of refernce before them while solving the problem or answering the question. These operations correspond more closely to actual on the job problem solving.

o Use of sound.

- Students can be given directions, have problems set and the context given for them.

- Level of skill may not be highlt correlated with verbal abilities.

- These testing offers a means of evaluating the competencies by means of pictorial non-verbal cues or by emphasizing realistic conversations.

- Presentation of realistic job sounds.

Both industry and government are concerned about skills training. Learners are taught functional literacy skills, equipment maintenance, programming, office skills, and so on. Much of this training is criterion referenced requiring content mastery. It is the author's belief that a more appropriate measure of skill retention would be a testing environment which closely approximates the instructional environment, assuming the assessment items are valid. This belief is indicated by the stimulus-generalization theory, which states that "the amount of information acquired by students increases as the testing situation becomes similar to the situation in which students receive instruction." (Szabo, 1981, p. 179) Miller (1957) tells us that generalization between two stimulus complexes is a direct function of the number of cues which they possess in common. Therefore, maximum learning for any combination of testing

channels will be highest when an instructional situation is identical to the testing situation.

A related cognitive phenomenon is cue summation theory which predicts that learning of discriminations is increased as the number of available cues or stimuli is increased. Therefore, if one stimulus complex is to be distinguished from another, the learner may use any number of cues in which the complexes differ to make a discrimination between them. Thus, increasing the number of cues increases the likelihood of a learner making correct discriminations (Hartman, 1961).

An intergration of the stimulus generalization and cue summation theories predict that an increase in the number of cues available in the presentation of information increases the recognition or discrimination of that information, provided the cues are also available in the related testing situation (Hartman, 1961). These theories strongly suggest testing situations which closely mirror the primary instructional delivery system.

It is also the author's belief that the closer both the instruction and testing environments approximate reality, the easier skill transfer becomes. Thelen (1945) felt that the more complete the presentation of situations by pictures and sound means that the pattern of stimuli comes closer to actual experience. Most testing strategies currently used to evaluate mediated instruction are pencil and paper types which are highly verbal, rather than visual, in nature. The reading skills required to take verbal tests may exceed those skills actually required by the job itself. Learners deficient in reading ability may not achieve test scores which appropriately demonstrate their ability to perform on the job; one major reason for using audio/visual testing is that these tests are not influenced to a large degree by verbal ability. The realness of the test situation is greater than with paper and pencil tests. Consequently, it should enable more valid predictions as to the behavior of students in similar real situations (Thelen, 1945).

Nugent (1982) tells us that the iconic system (that part of human cognitive structures primarily responsible for visual processing capablities) is presumably specialized in processing concrete objects and events, thus providing an overall schema. Linguistic presentation is specialized in providing a specific focusing orientation but not good at providing an overall schema. The two can interact and work jointly in facilitating learning. Learners process pictorial and linguistic information through functionally independent, though interconnected, cognitive systems. By conveying information through both linguistic and iconic symbols, learners are provided with complememtry processing systems, and they can alternate between the two to

obtain information. A properly designed and presented training/evaluation package on a computer/videodisc delivery system can facilitate the flexibility of these individualized storage, encoding and retrieval strategies.

Park (1972) believes that exams can be advanced two steps closer to 'reality' by paying more attention to the increase in visual and audio sensory inputs. This provides an additional reason for the use of a computer/videodisc delivery systems for testing.

Design of Assessment Items

This section will present suggestions for test item design using a single screen interactive computer/videodisc system with a high resolution graphics monitor having overlaying capabilities. This paper will discuss item design for assessment of various performance skill levels.

Visually based test items are written from specific training objectives. The use of pictorial test items is warranted only in specific assessment situations which call for visual presentation. Visually based items may be imbedded within instructional sequences to ascertain learner comprehension of the instruction and they also may be used to assess learner competency in pre and post testing situations.

Psychometricians have recognized a spatial ability factor as a component part of human intelligence. There is evidence which suggests that a semantic test measures a factorially different ability than a figural test (Tinsley and Dawis, 1972). It should be emphasized that the author is not suggesting that textual based testing be replaced by visually based test items. This author is simply proposing that the same instructional decisions which identified an interactive computer/videodisc training system as the appropriate instructional delivery medium should also be the basis for deciding which skills are appropriatly tested through a visual medium. Certainly, those skills which are better suited for verbal testing should be presented using a text based format (on or off line).

Test item designs should approximate, as closely as possible, the actual skill performance environment. Item validation is very important if we are to feel confident that the learner can perform the actual skills taught. For example, a video test may place the learner in a passive evaluative role of watching someone else performing each task. Success in this passive role does not ensure success on the active role of performing the same task. Therefore, it is important that the

test item match the actual performance objective.

The computer/videodisc system testing environment can have the learner enter responses via a keyboard, joystick, touch screen or voice if the responses are to be recorded on line (and the appropriate configuration exists). Test items can also be presented via the computer/videodisc system with the student responding on a paper response sheet.

The following is a list of test item designs for typical skill performance objectives. A brief discussion of the potential use for each item type will be presented.

- o If the performance objective is to assess the learner's comprehension of a particular part removal and replacement:

  - The test item could consist of series of removal sequences asking for visual identification of the proper sequence.
  - This last item could be extended to exposing the learner to complete removal sequences and asking for identification of the sequence which was performed in the correct removal order.
  - Isolated segments of removal sequences may be presented asking the learner to identify what the next task in the sequence would be.
  - Have learners arrange events in sequence by having them order a sequence of pictures.

- o If the performance objective is to have the learner identify components:

  - The learner could be asked to identify a component as it is presented in isolation.
  - Identify a component which is presented in the context of its actual operational environment.
  - Identify the component as it is removed from its environment.

- If the performance objective is to have the learner discriminate between components:

  - A picture could be presented containing a number of different components and the learner could be asked to find a particular piece.

  - A component could be matched with either its associated function or its name.

- If the performance objective calls for interpretation of results:

  - A video sequence could be presented asking the learner to indicate if the equipment is functioning correctly. This question could further ask the learner to identify what the problem is and how it would be corrected.

  - A sequence could be presented containing common procedural errors. The item may ask for an identification of these procedural errors and also ask the learner to interpret the results of these errors.

- If the objective calls for the ability to interpret equipment readings:

  - A still could be presented asking the learner to read a particular dial or calibrator.

  - An associated question could ask the learner to specify what might be the cause for the reading or what the reading might indicate.

- If the objective is for the learner to be able to specify location or setup:

- Present a still and have the learner specify erroneous or missing connections.

- Show a picture of equipment and ask where a specific part or connection should be placed.

- Put up a partial diagram and have the learner complete the diagram by choosing from a group of options or using free input.

o If the objective is to assess problem solving skills involved in troubleshooting:

- Present a problem to the learner and ask for a diagnosis the problem.

- Ask a learner to identify the component which is faulty.

- Ask learner to define the next or a series of steps to be taken to correct the malfunction.

- These evaluative problem solving simulations can become extremely complex using sophisticated programming and learner monitoring techniques similar to those used in computer assisted patient management problems in health science training. While it is certainly appropriate to use a computer/videodisc system for presenting evaluative simulations, the design and complexity of these problems are beyond the scope of this paper.

Related Suggestions for Test Development

Associated with the item design are issues of screen design and formatting. Appropriate presentation of the item is critical. The manner in which the test item is produced may bias the item in some way, so, it is important to pay close attention to screen layout. In addition, directions to the learner which explain specific item response are important. Due to screen design consideration, it may be appropriate to use audio to present these instructions and/or a visual identifier of some sort which cues the learner as to the kind of response expected.

Thelen (1945) used prerecorded test instructions in his work. Thelen felt that item instructions was the factor most variable in the administration of tests. Thus, by recording directions this test administration variable could be fixed.

In any multiple channel presentation system the designer must pay very close attention to the presentation of information. Care must be taken in presenting redundent channel information or a redundent channel message. Information presented may be unrelated or even contradictory which can be terribly confussing to the learner and may confound test results.

A related instructional and testing issue in the use of computer/videodisc system is the use of color as an important stimulus variable. Color may be used as a mechanism for directing learner attention. Color coding when applied to primary learning sequences helps to insure that 1) the central concepts being presented is emphasized, 2) that dissimilar concepts are differentiated, and 3) that related concepts may be categorized into groups. Care must be taken with the use of color because as the number of color coded items increase the value of color as an instructional cue decreases (Lamberski and Dwyer, 1983).

There are number of related issues associated with the use of visually based test items. If the test uses a fixed length format, the learner should be told how many items are in the test. There is no easy way of allowing the learner to scan through the test instrument, so, it is important to give the learner a sense of test length. Of course, if the test uses an adaptive testing format the length of the test will vary for each learner. Nonetheless, the learner should be made aware of the scope of these adaptive testing formats in advance of taking these tests.

Questions using motion are presented in a fixed sequence. The learner should have access to replaying these sequences. This is analogous to 'rereading' a question in a paper format. The learner should be allowed as much flexibility as possible in taking these test items.

A word of caution for test designers. It is crucial that all assessment items presented on line using a computer/videodisc system be designed, scripted and storyboarded as part of the instructional design phase of the project. This calls for front end planning and design of all evaluation instruments. It is very difficult to 'retrofit' a piece of instruction, which was never meant to be evaluative, into an assessment framework. An after-the-fact attempt at evaluation is very difficult unless a decision is made to go back into production to design and produce appropriate evaluation items, which is a costly endeavor. It is

much to the benefit of the instruction and evaluation to plan and design appropriate assessment items as part of the project instructional design process.

Associated Research and Measurement Considerations

The growing availablity and use of interactive computer/videodisc training systems increases the feasibility of using this medium as a means of evaluating learner comprehension and competency. The use of this assessment medium paves the way for the investigation of various basic research questions.

Psychometric qualities requiring further investigation are in the areas of item validation and item scoring. How is a test instrument which uses motion presentation 'different' in its measurement characteristics then a paper based instrument? How should visually based items be validated? How might the scoring of individual items differ from traditional dichotomous scoring methods? Are test items which are presented via motion presentations independent or are they interrelated? And, if so, how do these items affect the reliability of the test instrument?

Research investigating relationships existing between individual spatial abilities and success on visually based test items is warrented. Are there certain spatial skills necessary for learners to retain visual information? Is is possible for learners to retain visual information and be unable to transfer these skills? Can visually based test instruments be designed which are sensitive enough to assess a learner's ability to perform a specifically learned skill? What are the critical charactertics of visually based test instruments as these items interact with spatial ability skills?

An important research issue requiring further investigation is a identification of specific abilities and aptitudes which might be appropriately assessed using visually based test items. What are these characteristics and what is the most appropriate means of presenting these items using a computer/videodisc system?

The time is now for further investigation of these and related research areas. This author looks to practitioners and researchers alike in expanding our knowledge of visually based testing using interactive computer/videodisc systems.

Summary

The challenge of designing interactive computer/videodisc instructional courseware lies aheads. The merging of computer based instruction and videodisc technologies invites designers to devise new instructional strategies and modifications to existing methodologies uniting these presentation mediums. A logical extension for the use of these training systems is the assessment of learner competency and comprehension.

In summary, visually based test items may be used for learner assessment in skills training. As the testing environment more closely approximates the instructional environment skills retention may increase and become more easily transfered to actual operational environments. Pictorial based testing is a more visual based testing mode then conventional paper based testing presented using primarily a verbal format. It is suggested that test items presented using a verbal format may measure differing skills and abilities then test items presented using a visual format. The use of visually based test items is warranted only in specific assessment situations requiring visual presentation. Test items should approximate, as closely as possible, the actual skill performance environment.

Additional research investigation is necessary. Item validation and item scoring issues require futher inquiry. Research investigating relationships existing between individual spatial abilities and success on visually based test items is warrented. Another important research issue requiring further investigation is a identification of specific abilities and aptitudes which might be appropriately assessed using visually based test items.

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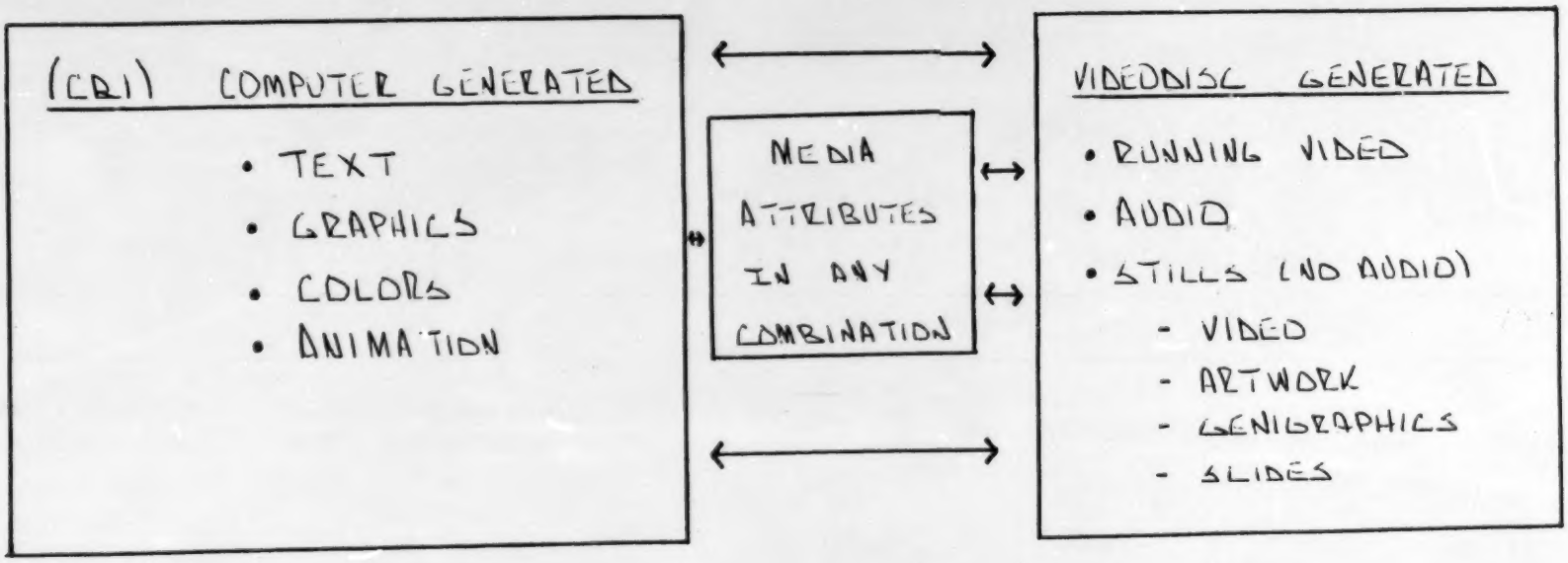
FIGURE 1



MEDIA ATTRIBUTES